A LOW LEVEL LOOK AT MAINTENANCE AND MAINTAINABILITY

DEFENSE SYSTEMS MANAGEMENT SCHOOL
FORT BELVOIR, VIRGINIA

MAY 1976

DEFENSE SYSTEMS MANAGEMENT SCHOOL

PROGRAM MANAGEMENT COURSE
INDIVIDUAL STUDY PROGRAM

A LOW LEVEL LOOK
AT MAINTENANCE AND MAINTAINABILITY

STUDY PROJECT REPORT
PMC 76-1

Patrick Edward Riley
Major USA

FORT BELVOIR, VIRGINIA 22060

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* A LOW LEVEL LOOK AT MAINTENANCE AND MAINTAINABILITY		5. TYPE OF REPORT & PERIOD COVERED Study Project Report 76-1 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Patrick Edward Riley		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS DEFENSE SYSTEMS MANAGEMENT COLLEGE FT. BELVOIR, VA 22060		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEFENSE SYSTEMS MANAGEMENT COLLEGE FT. BELVOIR, VA 22060		12. REPORT DATE 76-1 13. NUMBER OF PAGES 31
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

UNLIMITED

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

SEE ATTACHED SHEET

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

SEE ATTACHED SHEET

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

DEFENSE SYSTEMS MANAGEMENT SCHOOL

STUDY TITLE: A LOW LEVEL LOOK AT MAINTENANCE AND MAINTAINABILITY

STUDY PROJECT GOALS:

1. To describe the environment in which organizational maintenance takes place.
2. To illustrate doctrinal inputs to decisions on maintenance concepts for, and maintainability of, new equipment.
3. To examine briefly some of the above considerations as they are being applied to equipment currently under development.

STUDY REPORT ABSTRACT:

The report was written with the intention of providing a summary look at considerations given to making the task of maintenance at the using unit level simple and easy to perform. Examples showing the training, required skills and environment (to include operations) of the organizational Tracked Vehicle Mechanic are furnished. The MICV is used as an example of how equipment under development incorporates doctrine and recent lessons learned into the maintainability of the end product.

KEY WORDS

MATERIEL MAINTENANCE MICV ORGANIZATIONAL MAINTENANCE MAINTENANCE TRAINING MAINTAINABILITY

KEY WORDS: Training, Maintenance, Maintainability, Acquisition.

MAINTENANCE PERSONNEL

NAME, RANK, SERVICE	CLASS	DATE
Patrick E. Riley, Major, USA	PMC 76-1	May 1976

A LOW LEVEL LOOK

AT MAINTENANCE AND MAINTAINABILITY

Study Project Report

Individual Study Program

Defense Systems Management School

Program Management Course

Class 76-1

by

Patrick Edward Riley
Major USA

May 1976

Study Project Advisor
Mr. John Mathias, DAC

This study project represents the views, conclusions and recommendations of the author and does not necessarily reflect the official opinion of the Defense Systems Management School or the Department of Defense.

EXECUTIVE SUMMARY

The time devoted by the U. S. Army to the maintenance of equipment is long and often arduous. The opinion that today's equipment is too complicated and too hard to fix is one that has often been expressed. This report examines current doctrine, training, equipment and the chief "wrench bender", the organizational tracked vehicle mechanic to gain an understanding of maintainability considerations and how they are employed.

The report notes that the conditions under which the mechanic must work are far from ideal and should be considered when designing for maintenance. The technical documentation must be kept simple, accurate and usable. Training provided the mechanic must prepare him for what he will find when he joins his unit and must further train him on a variety of equipment for this is what he will find in the "real world".

The system utilized as an example in the report, the Mechanized Infantry Combat Vehicle or MICV, appears to be one in which maintainability is indeed a principal design parameter. The measures being taken to improve training by the Army's Training and Doctrine Command are steps in the right direction. However, the conclusion of the report is that the jury is still out on whether any, or all, of our current efforts will, in fact, make the mechanic's job easier and lessen the burden of maintenance on the commander.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

Background

Over the past several years, since expanding my experience base from an operational role in tank and armored cavalry units to staff officer in a logistics integrating center, I have heard of developments which supposedly make new items of equipment being introduced into the Army's inventory more supportable, more reliable and easier for the unit commander to employ. The requirement for such activities has been recognized for some time. One of the unit commander's biggest problems has been the necessity of keeping his equipment operationally ready to employ in accomplishing his mission. My experience has been that at least as much time has been spent on this aspect of command as has been spent on the operational employment of the unit. Thus any developments which improve the ability of the unit to maintain its equipment and improve its responsiveness to a mission requirement are to be ardently sought.

Purpose

With this in mind, this study project will seek to identify these developments, to determine what doctrine exists on easing the load on field elements and to examine some specific examples of how doctrine and new developments can or are being applied in given instances.

Scope

Examination of all actions taking place regarding logistics within the design of, and/or in support of, an item of equipment even within a service is beyond the time and resource constraints of this study.

Accordingly, in an attempt to gain some specific insights into the process and to avoid general statements which are difficult to apply in any given situation, this study will examine organizational maintenance and a given Military Occupational Specialty (MOS) in organizational maintenance, that of the 63C, Tracked Vehicle Mechanic (TVM). The TVM will be looked at from the standpoint of his role as a part of the Maintenance Section of an Armored Cavalry Troop. This is a "worst case" situation from the standpoint of types of equipment for which the individual is responsible, but will serve to amplify the importance of actions to make his job easier, to make his training better and to make the equipment easier to maintain.

The Mechanized Infantry Combat Vehicle (MICV), now in the engineering development phase of its acquisition cycle, will be used to illustrate some examples of actions taken from a hardware standpoint.

The U. S. Army Training and Doctrine Command (TRADOC) is currently studying several projects which may result in improved training for the TVM. One of these, Improved Technical Documentation, will be examined to illustrate training initiatives aimed at improving maintenance.

Finally, the relationships between items of hardware, personnel, operational environment and training will be examined to see how they interrelate and to enable a judgment to be made as to what progress has been made in the past several years.

Limitations

As the reader will note, the study is cast in somewhat of a personal context and as with all such efforts may contain bias. The sources of data, however, are current and the situations and equipment realistic. It is hoped that the results will illuminate a situation which can easily be

muddied with "buzz words", jargon of specific disciplines and a mountain of documentation.

CHAPTER II

DOCTRINE

General

In the broadest context, as logistics in support of the military establishment is a distinct and necessary part of military operations, so maintenance and maintainability is a part of logistics. Many words have been written about the importance of Integrated Logistics Support (ILS) considerations during the equipment/system life cycle and an examination of some of the documents pertaining to ILS and to the maintainability and maintenance concept aspects of ILS is an important prerequisite. In short, a look at the doctrine is appropriate before specifics are discussed.

Congressional Interest and DOD Input

Starting at the top, we find that recently Congress is becoming more and more aware that the costs of developing and acquiring a new system are only a portion of the total cost of ownership. The operations and support costs of systems after deployment are more and more of a factor with both Congress and Department of Defense (DOD) decision makers. In his annual DOD Report to Congress, former Secretary of Defense Schlesinger stressed the costs of O & S as they affect readiness. He further stressed the necessity for improving the visibility of these costs and that reliability and maintainability are key drivers of these costs. (1:A-VI-5,6)[1]

---

[1] This notation will be used throughout the paper for major references. The first number is the source listed in the bibliography. The second number, if given, is the page in the reference.

DOD

The principal DOD document pertaining to acquisition of major defense systems is DOD Directive 5000.1 dated December, 1975, and signed by Deputy Secretary of Defense Clements. In this directive, the component services are directed to consider logistic support as a principal design parameter with the magnitude of consideration appropriate to the phase of development for a particular system. In essence it states that early development will consider only necessary logistic parameters and that "...premature introduction of detailed operational support considerations is to be avoided". (2,5) The directive also contains guidance to the effect that logistic support requirements, as a part of operational suitability, will also be tested and evaluated prior to large-scale production commitments.

Two other DOD Directives, 5000.2 and 5000.28, address in detail the cost aspects of operation and support activities associated with a military system. It would be naive to assume that DOD in publishing these directives is not at least partially responding to Congressional pressures. In sum, the system Life Cycle Cost is becoming more and more prominent as a parameter to be considered when designing a new system. (3:1,2)

Still more specific is the direction provided in DOD Directive 4100.35, "Development of Integrated Logistics Support for Systems/Equipment". In this document are identified nine principal elements of ILS:

1. The Maintenance Plan
2. Support and Test Equipment
3. Supply Support
4. Transportation and Handling
5. Technical Data

6. Facilities

7. Personnel and Training

8. Logistic Support Resource Funds

9. Logistics Support Management Information (4:2,3)

As the report progresses, specifics addressing the majority of these principal elements will be discussed as appropriate to the maintenance concept employed, the training of the TVH and of some efforts to affect the technical data and documentation. Overall, 4100.35 provides the general guidance on the importance of ILS, the principal elements of ILS, and how and when they are to be addressed.

Military Standards published by DOD which address aspects of ILS in detail are contained within the bibliography of this report for those readers desiring to gain more depth but will not be addressed here in detail.

Army

Dropping down the line from DOD, the Army's implementing regulation for DODD 4100.35 is AR 700-127, published in April of 1975. As might logically be expected in an implementing directive, AR 700-127 goes into much more detail than does the DOD directive and ties in the Army documentation to the ILS process. For example, the combat developer (the Army's user representative) is directed to include or assure the inclusion of realistic, essential reliability, availability, maintainability and other support characteristics in Letters of Agreement (LOA), Required Operational Capability (ROC) documents for major systems and in Letter Requirements (LRs) for systems of lesser magnitude. The AR assigns responsibilities for testing ILS parameters, reviewing of procedures, and the

planning and managing of the ILS process for the Army. (8:1-2) The phasing of ILS considerations by life cycle phase is spelled out as are issues we will be addressing in later chapters such as the ILS Plan, the anticipated logistic environment and special logistic needs. AR 700-127 is the principal document governing ILS for the Army, and is thus the governing directive for implementing maintenance policies and concepts for new systems. It should be noted that the Army's developer, the U. S. Army Materiel Development and Readiness Command (DARCOM, formerly AMC) has published its supplement to the regulation and that the Army's user representative, the Training and Development Command (TRADOC) is in the process of writing a supplement for its elements. ARs 750-1, Army Materiel Maintenance Concepts and Policies and 702-3, Army Materiel Reliability, Availability, and Maintainability and TM 38-750, The Army Maintenance Management System amplify still further the logistic considerations and in particular the maintenance considerations.

The issues and documents contained in this chapter are illustrative of the doctrinal publications available for reference and guidance. They are by no means exhaustive, but are representative of doctrine and maintenance considerations as they might pertain to an individual mechanic and an item of equipment. The documents addressed will themselves provide enumerable further references should they be required.

CHAPTER III

THE ENVIRONMENT, PART I

Before even the most meaningful doctrine and guidance can be useful, it is necessary to have a firm grasp on the situation to which it is to be applied. In this chapter a detailed look at the tracked vehicle mechanic (TVM), a unit to which he might be assigned and the physical environments in which he might operate will be taken. In the following chapter, The Environment, Part II, an item of equipment now being developed and on which the TVM may well be required to perform maintenance will be discussed.

The Tracked Vehicle Mechanic (TVM)

The TVM upon his first exposure to his future military specialty is probably 18-19 years old, is physically fit and has demonstrated an aptitude for mechanical maintenance during the battery of tests he took upon entering basic training. He is headed for the Armor School at Fort Knox, Kentucky, where the Army's TVMs receive their formal schooling during a thirteen-week course "designed to provide them with the skills and knowledge required to perform organizational maintenance on wheeled and tracked tank-automotive vehicles". (9:I-1) (Note--The course is currently twelve weeks long, but is projected to extend to thirteen weeks in the summer of 1976. The Program of Instruction (POI) for the thirteen-week course is being used for purposes of this report, although it is still in draft form awaiting approval at TRADOC.) His (the TVM's) prerequisites for attending the course state that he attained a score of 90 or higher in the mechanical maintenance aptitude area and that he will have twelve or more months

of service remaining after he graduates from the course.

During the course he will receive some 443 hours of academic training as a tracked vehicle mechanic broken out as follows: (9:II-1)

Gasoline Engine (wheeled and tracked vehicles)	90 hours
Compression Ignition Engines	91 hours
Wheeled Vehicle Power Train and Chassis	78 hours
Tracked Vehicle Power Train and Suspension	42 hours
Preventive Maintenance Services for:	
Armored Personnel Carriers and Self-Propelled Howitzers	36 hours
Tanks	40 hours
Vehicle Driving	13 hours
Recovery Vehicles (operation and maintenance)	35 hours
Maintenance Management (publications and repair parts supply)	9 hours
Other Essential Training	9 hours
	443 hours

While the above are referred to as academic subjects, 95% of the training the TVM will receive is "hands on equipment", applied training. The course is designed to expose the TVM to the actual equipment he will see later and he learns on that equipment. Discussions with commanders and instructors at Fort Knox over the past year indicate that these knowledgeable people expect that the newly graduated TVM will be approximately 10-20% trained to operate as a mechanic in a field unit. The remainder of his expertise he will receive on the job from his supervisor, his fellow mechanics, the equipment Technical Manuals (TMs) and from experience. One further point about the young mechanic--his reading level will probably be

between the 7th and 9th grade levels. (This from a study conducted by the author while a Logistics Staff Officer at the U. S. Army Logistics Center.)

What is this young man's job description? What do the people who use his MOS in the various Tables of Organization and Equipment (TOEs) expect him to do when they include his MOS in the makeup of a unit? For the answer to these questions, we look to Army Regulation 611-201, Change 25 dated 26 October 1972, which contains the duties, skills and knowledge requirements for Army Enlisted Personnel and we find that he: (10:649)

Reads workorders and other forms.

Performs detailed diagnostic checks on wheel and tracked vehicles.

Interprets and applies information contained in TMs, technical bulletins and lubrication orders.

Tightens.

Adjusts.

Times.

Tunes.

Replaces.

Drives.

Operates (wreckers and tracked recovery vehicles).

And, as a knowledge requirement, he must know how to do the above. Quite a task for the new graduate. One further point before the unit to which he may be assigned is examined. In many units the number of school-trained mechanics (TVMs) actually on hand falls short of the number authorized. If the discrepancy is severe, the unit commander may well assign untrained personnel as mechanics to keep the equipment operational. The intention is usually to make the assignment temporary; in actuality it is

often permanent. These untrained people must learn their new job while actually performing. Many will have had experience on civilian cars or trucks and a few may have worked on construction equipment. With a qualified supervisor and help from their fellow mechanics, the majority perform very well; but due to the pressure requiring their "interim" assignment in the first place, they constantly lag in their knowledge behind their trained fellow mechanics.

The Unit

Tracked Vehicle Mechanics are found in many different types of Army units: Mechanized Infantry, Artillery, and Tank Companies and Battalions and in Armored Cavalry Troops and Squadrons. For this report the Armored Cavalry Troop has been selected. The "Cav" Troop has a greater variety of vehicles and operates in more diverse operational situations than any similarly sized unit in the Army and was selected for those reasons. It is a "worst case" situation and will serve to amplify the issues being addressed. Figures 1 and 2 have been extracted from the FY1976 edition of Armor Reference Data, published by the U. S. Army Armor School as a training and reference document. Illustrated is the organization and equipment of a typical troop in Figure 1 and their configuration for movement in Figure 2.

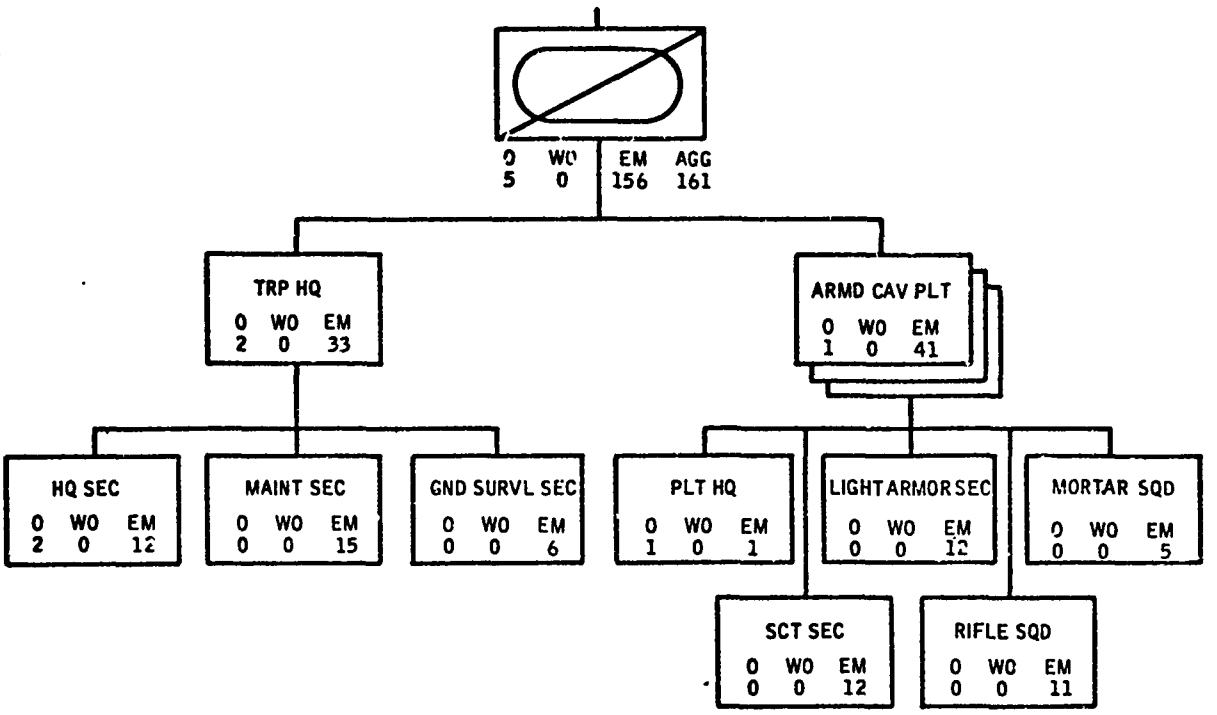
In Figure 1 note that there are 15 people assigned to the Troop Maintenance Section. They are:

Title	Rank	#
Motor Sergeant	E-7	1
Senior Tracked Vehicle Mechanic	E-5	1
Tracked Vehicle Mechanics	E-3, E-4	4
Tracked Vehicle Mechanics Helpers	E-2, E-3	2

MISSION. To provide security and perform reconnaissance for the unit to which assigned or attached and to engage in offensive, defensive, or delaying action as an economy-force unit.

ASSIGNMENT. a. Organic to Armored Cavalry Squadron, TOE 17-105.
b. Organic to Separate Armored Brigade, TOE 17-100.
c. Organic to Separate Infantry Brigade, TOE 7-100.
d. Organic to Separate Mechanized Brigade, TOE 37-100.

CAPABILITIES. a. Performs reconnaissance and provides security for unit to which assigned or attached.
b. Engages in offensive, defensive, or delaying actions.
c. Conducts independent action when properly reinforced.



SUMMARY OF EQUIPMENT

WEAPONS	
GUN/LAUNCHER 152-MM BILI	9
LAUNCHER GRENADE M203	22
MACHINEGUN CAL .50 HB FLEX	1
MACHINEGUN CAL .50 HB BILI	36
MACHINEGUN 7.62-MM FLEX	3
MACHINEGUN 7.62-MM BILI	25
MORTAR 4.2-INCH BILI	3
PISTOL CAL .45	45
RIFLE 5.56-MM	116
SUBMACHINEGUN CAL .45	20
VEHICLES AND VEHICLE EQUIPMENT	
ARMORED RECONNAISSANCE/AIRBORNE ASSAULT VEH M551	9
CARRIER CMD AND REC M114A1	16
CARRIER MORTAR M106A1	3
CARRIER PERSONNEL FULL TRACK M113A1	7
RECOVERY VEHICLE LIGHT M578	1
TRAILER CARGO 1/4-TON M416	1
TRAILER CARGO 1-1/2-TON M105A2	2
TRUCK CARGO 2-1/2-TON M35A2	2
TRUCK UTILITY 1/4-TON M151A1	2
COMMUNICATION-ELECTRONICS EQUIPMENT	
INTERCOMMUNICATION SET AN/VIC-1	3
RADAR SET AN/PPS-5	2
RADIAC METER IM-93/UD	19
RADIAC METER IM-174/PD	5
RADIAC SET AN/PDR-27	1
RADIO SET AN/GRC-106	1
RADIO SET AN/GRC-160	8
RADIO SET AN/PRC-77	3
RADIO SET AN/VRC-12	7
RADIO SET AN/VRC-46	7
RADIO SET AN/VRC-47	3
RADIO SET AN/VRC-64	13
RADIO SET CONTROL GROUP AN/GRA-39	4
SWITCHBOARD TEL MANUAL SB-22/PT	1
TELEPHONE SET TA-1/PT	6
TELEPHONE SET TA-312/PT	7
MISCELLANEOUS EQUIPMENT	
BINOCULAR ELECTRONIC AN/PAS-5	5
DETECTING SET MINE MICROWAVE AN/PRS-4	3
DETECTING SET MINE PTBL METALLIC	3
METASCOPE AN/PAS-6	13
NIGHT OBSERVATION DEVICE AN/TVS-4	2
NIGHT SIGHT CREW WPNS AN/TVS-2	27
NIGHT SIGHT INDIVIDUAL WPNS AN/PVS-2	29
RANGE FINDER AN/GVS-3 (LASER)	3
SEARCHLIGHT AN/VSS-3	9
TELESCOPE	9

ARMORED CAVALRY TROOP, ARMORED CAVALRY SQUADRON
ARMORED AND MECHANIZED DIVISION
SEPARATE ARMORED, MECHANIZED, INFANTRY BRIGADE

Figure 1 (11;47)

TROOP HEADQUARTERS

HEADQUARTERS SECTION

AN/VRC-47
AN/GRA-39

1 CPT (Comdr) P
1 PFC (Dvr) R, GL

AN/VRC-12

1 SSG (Veh Comdr) P
1 SP4 (Pers Carr Dvr) P

1 SSG (Sup SGT) R
1 PFC (Sup Clk) (Dvr) R

AN/VRC-47
AN/GRC-106

1 1SG (First Sergeant) R
1 SSG (Comm Chief) R
1 SP5 (Unit Clk) R
1 SP4 (Sr Rdo Op) R
1 SP4 (Armorer) R
1 SP4 (Pers Carr Dvr) P
1 PFC (Rdo Op) R

Note. XO assigned HQ Sec located in Maint Sec.

GROUND SURVEILLANCE SECTION

AN/[illegible]
AN/GRC-160

1 SSG (Sec Ldr) R
1 SP5 (Sr Radar Op) R
1 SP4 (Radar Op) (Dvr) R, GL

AN/PPS-5
AN/GRC-160

1 SGT (Tm Ldr) R
1 SP5 (Sr Radar Op) R
1 SP4 (Radar Op) (Dvr) R, GL

AN/VRC-47

1 LT (XO) R
1 PFC (Track Veh Mech Hlpr) (Dvr) R

MAINTENANCE SECTION

1 SFC (Motor SGT) R
1 SP5 (Sr Fld C E Eq Mech) R
1 SP4 (Track Veh Mech) R
1 SP4 (Sheridan Trt Mech) R
1 PFC (Track Veh Mech Hlpr) (Dvr) R

AN/VRC-64

1 SP5 (Sr Track Veh Mech) R
1 SP5 (Sr Sheridan Trt Mech) R
2 SP4 (Track Veh Mech) R
1 SP4 (Fld C E Eq Mech) R
1 SP4 (Equip Records Clk) R, GL
1 SP4 (Track Veh Mech) (Dvr) R

AN/VRC-46

1 SP5 (Sr Recov Veh Op) P, S
1 SP4 (Recov Veh Op) P, S

* Mounts 10E cal .50 mg on ring mount

Note. XO is assigned to HQ Sec

(3) ARMORED CAVALRY PLATOON

PLATOON HQ

AN/VRC 12
AN GRA 39

1 LT (Plt Ldr) R
1 SP4 (Sct Dvr) R

SCOUT SECTION

AN VRC-46

1 SSG (Sec Ldr) R
1 SP4 (Sct Dvr) R
1 PFC (Sct Obsr) R, GL

AN/GRC 160

1 SGT (Asst Sqd Ldr) R
1 SP4 (Sct Dvr) R
1 PFC (Sct Obsr) R, GL

AN/VRC-46

1 SSG (Sqd Ldr) R
1 SP4 (Sct Dvr) R
1 PFC (Sct Obsr) R, GL

AN/GRC 160

1 SGT (Asst Sqd Ldr) R
1 SP4 (Sct Dvr) R
1 PFC (Sct Obsr) R, GL

RIFLE SQUAD

AN/VRC-64
AN/PRC 77
AN/VIC 1

1 SSG (Sqd Ldr) R
2 SGT (Tm Ldr) R
2 SP4 (Auto Rifleman) AR
2 SP4 (Grenadier) R, GL
1 SP4 (Pers Carr Dvr) R
3 PFC (Rifleman) R
1 7.62 mm mg

LIGHT ARMOR SECTION

AN VRC 12

1 SFC (Plt SGT) P
1 SP5 (Gunner) P, S
1 SP5 (Dvr) P
1 PFC (Loader) P, S

AN VRC-64

1 SSG (Comdr) P
1 SP5 (Gunner) P, S
1 SP5 (Dvr) P
1 PFC (Loader) P, S

AN/VRC-64

1 SSG (Comdr) P
1 SP5 (Gunner) P, S
1 SP5 (Dvr) P
1 PFC (Loader) P, S

MORTAR SQUAD

AN/VRC-64

1 SGT (Sqd Ldr) R
1 SP4 (Mortar Gnr) P
1 SP4 (Mortar Carr Dvr) R
1 PFC (Asst Mortar Gnr) R
1 PFC (Ammo Bearer) R
AN/GVS-3 (Laser)

Figure 2 (11:48)

Senior Recovery Vehicle Operator	E-5	1
Recovery Vehicle Operator	E-4	1
Senior Turret Mechanic	E-5	1
Turret Mechanic	E-4	1
Equipment Records Clerk	E-4	1
Senior Field C-E (Communications-Electronics) Mechanic	E-5	1
Field C-E Mechanic	E-4	1
		15

The TVMs are not responsible for maintenance of tank turrets nor for the C-E equipment on the vehicles.

In Figure 2 can be seen the illustrative silhouettes of the troop vehicles. Although there are seven different vehicles listed in Figure 1, there are only six different vehicle types for the mechanic to work on, the M106A1 Mortar Carrier being an adaption of the M113A1 Armored Personnel Carrier. Different locations and different parent units will find different vehicles included in the Armored Cavalry Troop. The unit illustrated is but one example, although the number of different types of vehicles will remain about the same.

Work Situations

There are basically three sets of working situations which a typical unit and thus the TVM may experience. They are garrison, field training and combat. The actual climatic conditions prevailing in any of the three situations may vary from below freezing temperatures with strong winds and snow, to hot, humid, and muddy. As many a military man has observed, however, there never seems to be a perfect situation for a fight.

In peacetime, garrison operations are normal for the troop with perhaps as much as 90% of the available working time spent in garrison with the other 10% spent in field training. The garrison situation is as close as the TVM will come to his civilian counterpart who may work in a filling station or garage. Generally speaking the maintenance shop is a fixed structure, lighted and heated, with overhead cover to work under. There are tool rooms, rooms to store repair parts, vehicle wash racks, grease pits and other amenities. Garrison conditions are good for further training in the basics and for performing effective maintenance, but must be watched closely lest they become the conditions for which maintenance on new systems is designed and which the training of new mechanics is based upon. As so much time in peacetime is spent in garrison, it quickly becomes the norm, but little resembles the conditions in which the equipment should be designed to operate and under which it must be supported effectively, those of combat.

As an attempt to simulate combat, the Army utilizes field training. In the field the unit leaves its fixed shops and facilities behind and hopefully operates using the equipment authorized it as a combat unit. If power is required to operate some tools or lights, it must be supplied by generators. If repair parts are required they must either be obtained from those carried on the maintenance section's vehicles (the truck and trailer, the recovery vehicle or the Armored Personnel Carrier), or if not available, the vehicle evacuated or a field expedient applied. When a vehicle breakdown occurs, it must be fixed where the failure occurs, not on a hardstand and often in mud. Field training can be and often is excellent training for maintenance support in combat. The following situations

should be remembered and prevented:

1. It is easy to leave some repair parts back in garrison; after all an admin run will be coming out every day.
2. Preventive maintenance services can be put off until the return to garrison where they will be easier to do.
3. No one is shooting at you; therefore, a light won't hurt at night.
4. No one has to pull security duty; therefore, the mechanics are all available for maintenance.

The above situations do not represent training for combat, and by the same token, tests of new equipment and maintenance on that equipment which allow the above are not a true test of what the mechanic must do under combat conditions.

In the combat situation itself experience has indicated that organizational maintenance becomes breakdown oriented. Conditions and time permitting, some preventive maintenance such as checking oil levels, track tension or water levels may be performed, but the majority of services await the unit's next "stand down" which for a cav troop doesn't come. The tendency, therefore, is to fix the vehicle when and where it fails. By this time the failure is often major and requires a great deal of time and expertise. The U. S. Army Forces Command has recently been evaluating a version of the above situation, prolonging periods between services and using a "service station" maintenance concept where services are available at a fixed point. Whether this may provide a partial answer, whether new equipment should be designed with this in mind or whether a combination of the two might be best has yet to be determined.

CHAPTER IV

THE ENVIRONMENT, PART II

The Maintenance System

In Chapter III, the TVM, a sample unit and the working environment of the TVM were examined. In this chapter the other levels of maintenance which impact on the TVM will be briefly addressed as will new equipment now under development.

Although the TVM and his role in organizational maintenance has thus far been looked at in isolation, it should be readily apparent that he does not so exist in real life and that he does not in fact have to accomplish all tracked and wheeled vehicle maintenance by himself. The TVM is really the second tier of organizational maintenance; the first level is the equipment user or users. The maintenance requirements of the user are essentially preventive in nature and consist of such things as checking oil levels, cleaning, periodic servicing to include lubrication and reporting malfunctions to the unit maintenance section. Instructors of the Senior Officer's Preventive Maintenance Course at Fort Knox, Kentucky, estimated that effective preventive maintenance by the user or crew could eliminate at least half of the maintenance failures being experienced on today's Army equipment. If this is true, then the maintenance training of the crews is at least as important as the training of the mechanics. Aside from the actual performance of preventive maintenance by the users, the prompt recognition and reporting of pending or actual failures on the equipment is essential for two reasons: first, correction should be accomplished before further damage results to the failed item and second, it

is usually easier to fix the item in question if the fault is detected early. (12:24)

Above the combat unit level (organizational maintenance is also performed at squadron/battalion level) is found both Direct Support (DS) and General Support (GS) Maintenance. Within the Army Division DS is the support maintenance activity supporting the line units. In a broad sense, it is the first level at which any "repair" is performed. Lower levels, to include TVM, primarily replace defective parts as opposed to repairing them. DS also involves mostly replacement but as noted does some limited repair. GS, normally found in Corps support elements, backs up DS in the Division as DS backs up the line battalions. Both DS and GS units have contact teams which can go forward to the line units and either repair or supervise repairs of equipment. Under a new concept, Commodity Oriented General Support (COGS), more use of contact teams is envisioned, a further assist for the TVM. (13:21)

New Equipment

The Army is currently emphasizing maintainability considerations in the development of new equipment. An Army Maintainability Symposium was held in September, 1975, with the theme of "bridging the gap" existing between producers of maintainable equipment, those writers of maintainability requirements and those who must use and maintain the equipment. Discussed in detail at the symposium was Logistics Support Analysis (LSA) which, when perfected, will provide a "systematic process for reviewing and determining the support implications of all performance characteristics and design features", and the LSA influence on support requirements and replacement unit analysis. (14:353-355)

The MICV

One of the vehicles used as an example to illustrate the ISA process during the symposium was the Mechanized Infantry Combat Vehicle (MICV). Cited was the fact that some 215 maintenance-related design recommendations had been made on the MICV. These recommendations varied from such things as an access port so that the starter could be removed without removing the power plant, to standard fasteners which lessened the overall tool requirements to repair the vehicle.

As an indication of what actions take place to ease the maintenance burden of a new piece of equipment, the Executive Summary of the In-Depth Design Review conducted in early 1976 on the MICV shows the following:

Fuel Filter - Design currently calls for removal of three screws, lifting and locking of a cover plate and extraction of a filter hose to drain the filter. After draining, the process must be reversed. The review committee recommended relocation of the filter for easier access and the inclusion of an external drain hose.

Ground Hop Kit - The vehicle specification requires testing of the powerpack prior to replacement at organizational level. Field units are not authorized a kit to perform this test. The committee recommended issuance of a ground hop kit to receiving units and a reconfiguration of the vehicle cooling system to facilitate its use.

These two examples illustrate the level of detail to which maintenance considerations are made in developing a new system. They are by no means all inclusive.

The MICV is a good example of the Army's increased emphasis on maintainability. As noted in the report of a representative of the Organizations and Systems Research Laboratory, "Maintainability considerations seem to have been given a higher priority at an earlier phase of development in the MICV program than in any other ground vehicle program for which information is available." (15:1) The report goes on to note the MICV effort to reduce the number of fastener drives and sizes is improving the general maintainability of the equipment while at the same time reducing the tool requirement.

Although the MICV is a good example of what's being done with equipment now being developed, the Army has been attempting to simplify maintenance requirements for many years. The oil level sight glasses in the road wheels of the M113 Armored Personnel Carrier made it much easier to check on this vital lubrication checkpoint and thus made it more likely that it would be checked. The overall attitude of the designers and developers seems to be one of "keep it simple, easy to get to, require fewer tools and make it easy to diagnose". This attitude is paying off as maintenance from the equipment user level to depot level is more apt to be performed as required and is less time-consuming to perform. These factors, when combined with an increase in overall equipment reliability, will do much to relieve the burden on the commander and allow him more time for mission considerations.

CHAPTER V

TRAINING

As noted in earlier chapters, the U. S. Army Armor School is the location of formal training for the TVM. It is also the training ground for armor crewmen and junior leaders. Under TRADOC policies, however, the school does more than just train troopers. To illustrate the school's viewpoint:

> "At the Armor School, we consider ourselves a requirement generator, a user, and the intercessor on behalf of the user--the troops....That involves identifying and analyzing new job tasks generated by equipment and tactics and then designing training programs to introduce them into the Army." (16:13)

In pursuit of its goals, the Armor School and the other Army service schools under TRADOC have a continuing effort not only to turn out a well-trained product, but also to interface with the developer in turning out training materials which can be used by the troops in the field to master the peculiarities of new equipment as well as better ways of fixing the old. Yearly, each company-size unit receives from the service school responsible for the training of the majority of its personnel a copy of the latest correspondence courses, instructional support materials, training devices and pamphlets containing the latest available information and guidance on maintenance and equipment as well as many other areas. The unit commander and the mechanic can request these materials to improve their training in their work environment. (17:3-4)

TRADOC, with the active participation of its schools, is currently producing multimedia training packages under the Training Extension Course (TEC) Program. TEC courses for critical tasks are developed by the

schools, put together and packaged by a contractor proficient in training technology and visual aids, tested, validated, and furnished free of charge to those units whose personnel must perform these critical tasks. Some of the tasks for which TEC programs have already been fielded include Prescribed Load List (PLL) procedures, Cleaning and Maintenance of the M16 Rifle and a host of others. The program is expanding as resources permit, and the goal is coverage of all critical tasks in the MOS inventory. Some of the courses are a combination of cassette recordings, a tape player (portable) and a pamphlet. The soldier performs his hands-on training while listening to the tape and referring to the pamphlet for illustrations and clarification. Still other packages utilize a video cassette with sound played on a machine which resembles a small television set. Others use only printed materials. Whichever media best fits the environment in which it will be used is the one developed. The hardware, including the tape players and video cassette devices, has already been furnished most of the using units.

Currently underway at the U. S. Army Logistics Center (LOGC) at Fort Lee, Virginia, is a joint project between the Army's developer, DARCOM, and its user representative, TRADOC. The LOGC, an integrating center for logistics under TRADOC, is currently pursuing Improved Technical Documentation and Training (ITDT). Studies and reports over the past several years indicated that deficiencies in the methods of technical manual development were contributing factors to ineffective maintenance training. In early 1975 a conference was held at TRADOC to determine a means of providing better maintenance procedures for Army equipment. Subsequently, DARCOM was invited to participate, and in May, 1975, general officers from

all headquarters concerned met to hear MG Gorman, Deputy Chief of Staff for Training, TRADOC, introduce a new concept for marrying technical documentation and training--ITDT.

The traditional approach to maintenance training and documentation has been to provide general, theoretical basics through formal training and to use technical manuals to describe system specifics. The maintenance personnel in the field would then combine the two to determine what to do in a given situation. The basic problem with this approach was that conventional technical manuals were incomplete and difficult to understand. Information required was scattered throughout the manual requiring a great deal of cross-referencing. (18:2) As a result of these basic deficiencies, the editors of PS MAGAZINE, a basic maintenance items magazine published monthly by the Army's Maintenance Management Center in Lexington, Kentucky, noticed many letters coming in from the field with questions, the answers to which should have been available in the TMs. As PS is published for the purpose of clarifying these issues as well as lessons learned in a simple, comic book format, the letters went to the right place. The number of queries, however, indicated that remedial action was necessary by some other means, preferably by improving the TMs as 89% of the letters concerned problems with TMs. (18:12) The ITDT approach involves:

1. Experts analyze equipment.
2. Optimum procedure developed for each maintenance operation.
3. Training tasks defined.
4. TM describes optimum procedure step by step in clear text combined with clear illustrations.

5. Training media selected and a training package prepared.

ITDT appears to be a combination of a revised format and lowered reading level for the technical manuals and includes some of the TEC features mentioned earlier such as field validation. The training employing ITDT, however, will include that done in institutions (schools) as well as in the field. The methodology will thus be reinforced for the individual as he uses the packages and TMs in his unit. ITDT is still a concept and recommended demonstration projects are now being discussed. Among the equipment recommended are the MICV and the XM-1 Tank, both developing systems.

CHAPTER VI

SUMMARY

The recognition now being given to maintenance and maintainability by the Department of Defense and by its component service, the U. S. Army, is significant. On the future battlefield where mobility may well be one of the major determinants of success, the ability of a commander to keep his vehicles operational and in fighting condition will literally be one of life and death. From the crew member who performs preventive maintenance, to the mechanic who has to figure out what's wrong and how to fix it, to the commander who must fight with dwindling resources, maintainability is more than a principal design parameter, it's reality under hazardous conditions.

As can be observed in the report, the literature and doctrine is available and growing. The Army's service schools are doing their best to turn out an accomplished, if inexperienced, graduate, and the training commands are attempting innovative approaches to both school training and to training in the unit. New field training guides called ARTEPs (Army Training and Evaluation Procedures) are now being published and will provide guidance on how to conduct training under simulated combat conditions, what training is essential and how the training can be evaluated to determine where further training is required.

The materiel developers and their program managers are actively engaged in producing more reliable and more maintainable equipment. The true test results, where we see if that greasy guy under the vehicle on a

rainy day in the mud can actually do his job effectively, are still prevailing. The prognosis appears favorable.

BIBLIOGRAPHY

1. Schlesinger, James R. Secretary of Defense, Annual Defense Department Report, FY1976 and FY1975, 5 February 1975.

2. Department of Defense. Directive 5000.1, Acquisition of Major Defense Systems, 22 December 1975.

3. Bennet, Dr. John J. Acting Asst. Secretary of Defense, "Comment", Defense Management Journal, January, 1976.

4. Department of Defense. Directive 4100.35, Development of Integrated Logistic Support for Systems/Equipments, 1 October 1970.

5. MIL-STD-490 with changes 1 and 2, Specification Practices, 30 October 1968, C1, 1 February 1969, C2, 18 May 1972.

6. MIL-STD-721B, Definition of Effectiveness Terms for Reliability, Maintainability, Human Factors and Safety, 25 October 1966 w/C1 10 March 1970.

7. MIL-STD-1388-1, Logistic Support Analysis, 15 October 1973.

8. Department of the Army. Regulation 700-127, Integrated Logistics Support, 11 April 1975.

9. Program of Instruction (draft), Tracked Vehicle Mechanic Course 611-63C10, January 1976.

10. Department of the Army. Regulation 611-201, Enlisted Military Personnel Occupational Specialties, Change 25, 26 October 1972.

11. Department of the Army. U. S. Army Armor School, Armor Reference Data, FY1976.

12. Ebert, LTC Vernon E. "The M60A2 in Perspective," Armor Magazine, January-February, 1975.

13. Stivison, LTC James R. and Wagenheim, LTC Richard M. "Commodity Oriented General Support," Army Logistician, January-February, 1976.

14. Eicher, BG William E. Equipment Maintainability--Design In, Don't Add On," National Defense, March-April, 1976.

15. Memorandum for Record, Organizations and Systems Research Laboratory, U. S. Army Research Institute for the Behavioral and Social Sciences, 25 April 1974.

16. "Man Machine Interface," Armor Magazine, May-June, 1975.

17. Riley, MAJ Patrick E. "Logistics Training Packages", a Staff Study done for the U. S. Army Logistics Center, May, 1974.

18. Cooper, Leslie M. Briefing presented to CG, USALOGC in February, 1976.